Patterns for Testing Debian Packages

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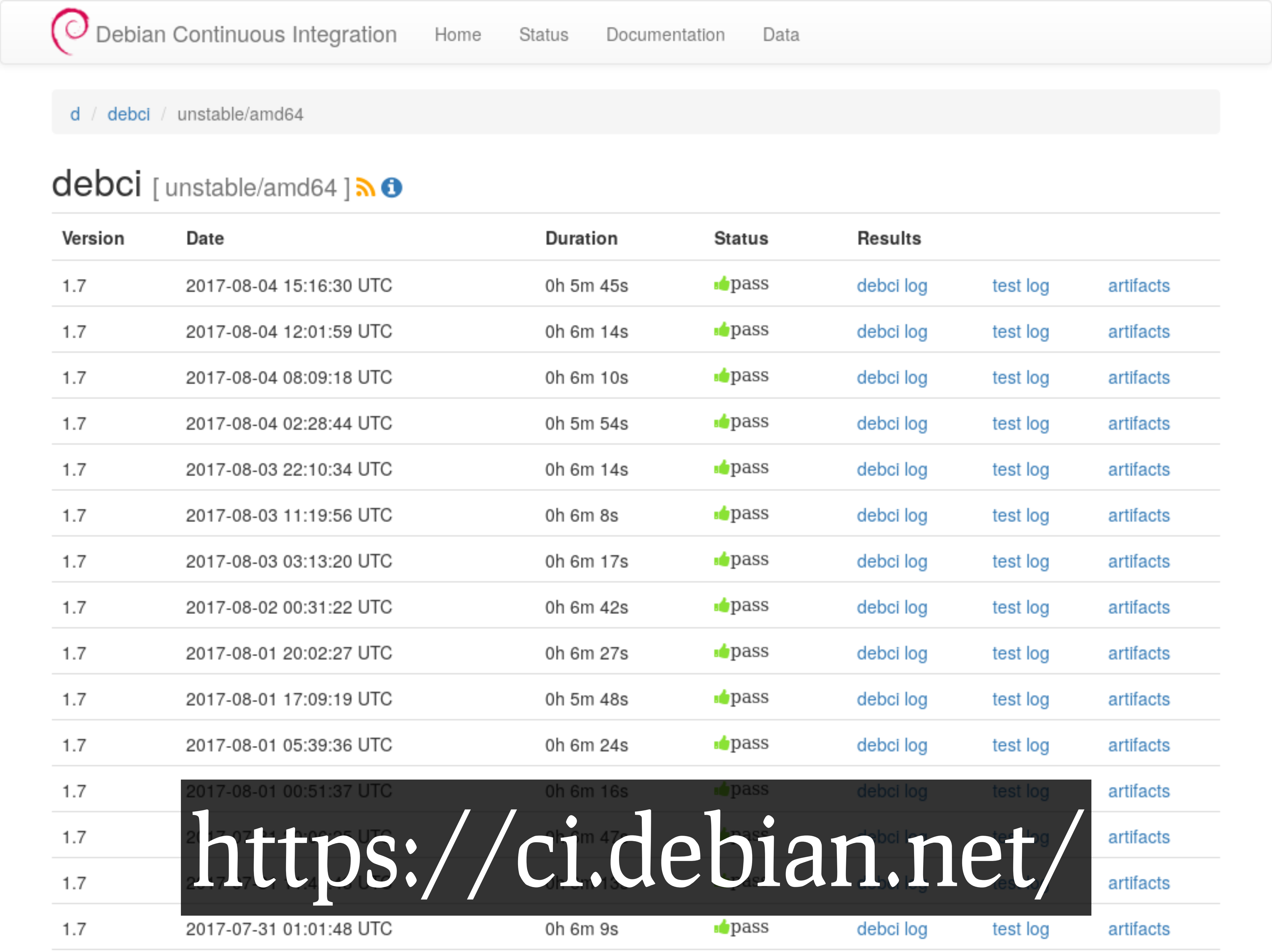
A brief intro to Debian CI

- autopkgtest created back in 2006 (!)
- 2014: Debian CI launches
- Goal: provide automated testing for the Debian archive (i.e. run autopkgtest for everything)
- Plans: gate migrations from `unstable` to `testing`

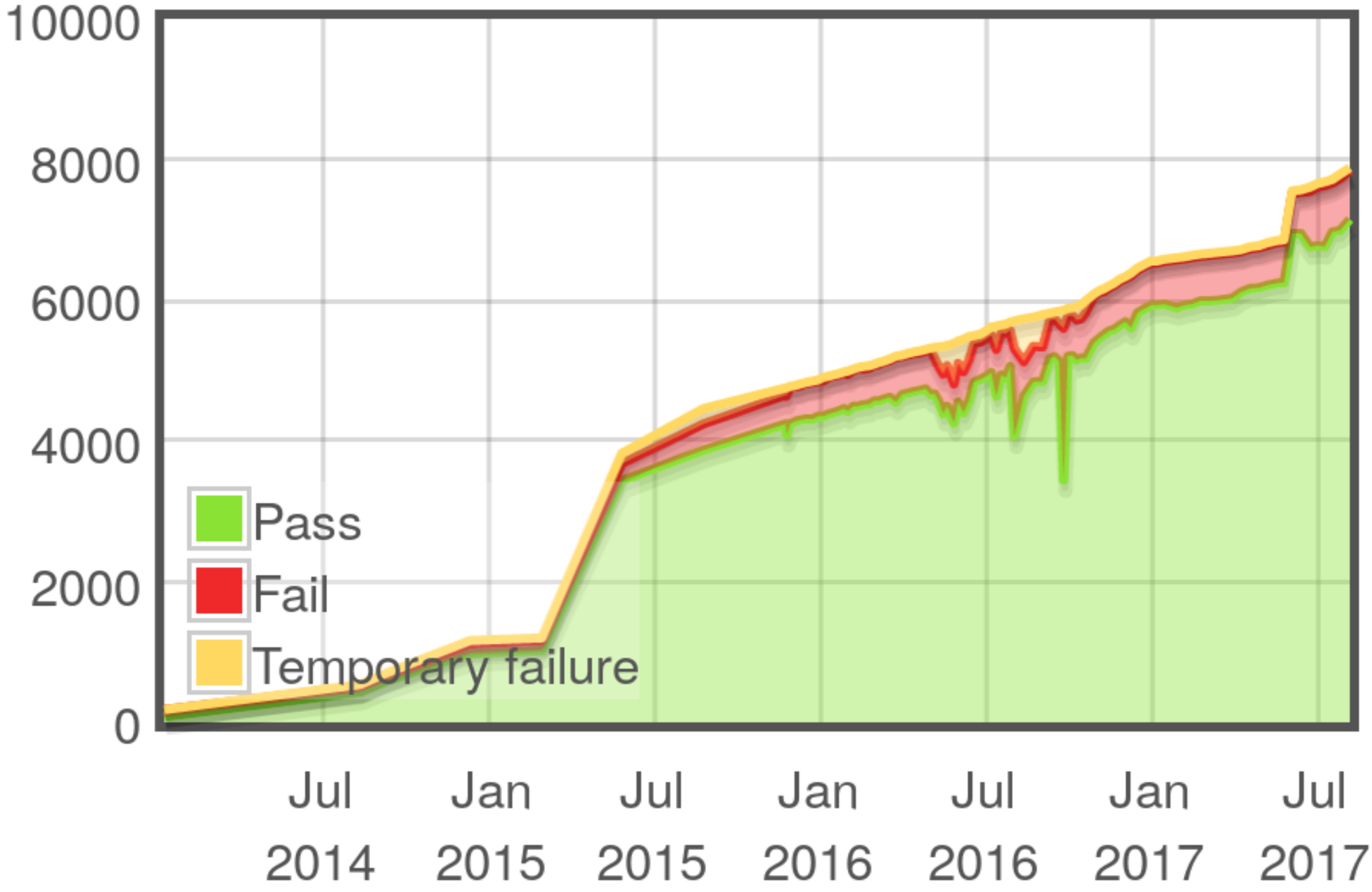


d / debci / unstable/amd64

debci [unstable/amd64]

Version	Date	Duration	Status	Results		
1.7	2017-08-04 15:16:30 UTC	0h 5m 45s	pass	debci log	test log	artifacts
1.7	2017-08-04 12:01:59 UTC	0h 6m 14s	pass	debci log	test log	artifacts
1.7	2017-08-04 08:09:18 UTC	0h 6m 10s	pass	debci log	test log	artifacts
1.7	2017-08-04 02:28:44 UTC	0h 5m 54s	pass	debci log	test log	artifacts
1.7	2017-08-03 22:10:34 UTC	0h 6m 14s	pass	debci log	test log	artifacts
1.7	2017-08-03 11:19:56 UTC	0h 6m 8s	pass	debci log	test log	artifacts
1.7	2017-08-03 03:13:20 UTC	0h 6m 17s	pass	debci log	test log	artifacts
1.7	2017-08-02 00:31:22 UTC	0h 6m 42s	pass	debci log	test log	artifacts
1.7	2017-08-01 20:02:27 UTC	0h 6m 27s	pass	debci log	test log	artifacts
1.7	2017-08-01 17:09:19 UTC	0h 5m 48s	pass	debci log	test log	artifacts
1.7	2017-08-01 05:39:36 UTC	0h 6m 24s	pass	debci log	test log	artifacts
1.7	2017-08-01 00:51:37 UTC	0h 6m 16s	pass	debci log	test log	artifacts
1.7	[illegible]	[illegible]	pass	debci log	test log	artifacts
1.7	[illegible]	[illegible]	[illegible]	debci log	test log	artifacts
1.7	2017-07-31 01:01:48 UTC	0h 6m 9s	pass	debci log	test log	artifacts

https://ci.debian.net/



~8k source packages

~28% of the archive

~21 packages/day
since January 2014

As a CI proponent, I have read and written tests for several packages.

I started to notice, and suggest, similar solutions to recurring problems … and thought they could/should be documented.

Patterns

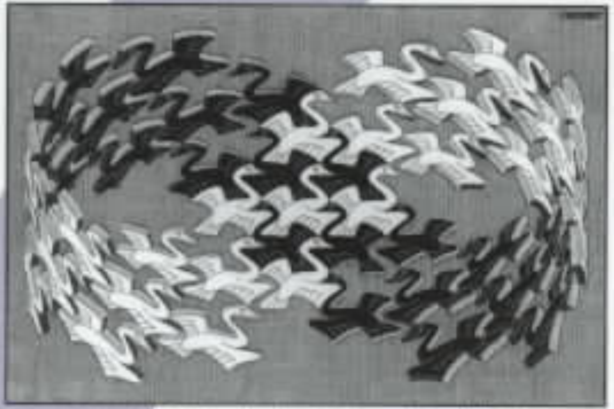
A **pattern** is a re-usable, documented solution to a recurring problem

Often used in design disciplines, such as architecture and software engineering

Design Patterns

Elements of Reusable Object-Oriented Software

Erich Gamma
Richard Helm
Ralph Johnson
John Vlissides



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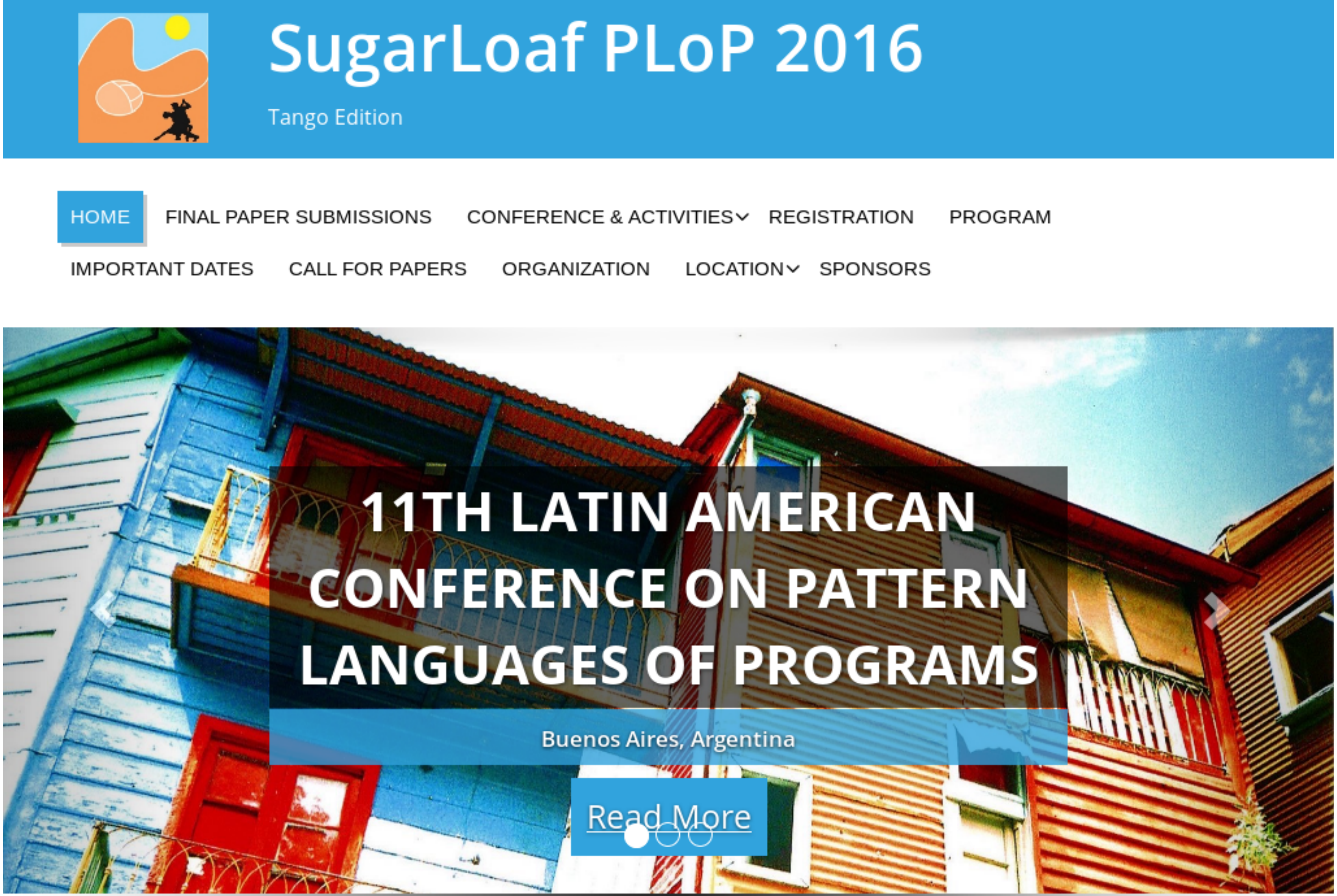
Foreword by Grady Booch

SOFTWARE Development PRODUCTIVITY AWARD

ADDISON-WESLEY PROFESSIONAL COMPUTING SERIES



SugarLoaf PLoP 2016

Tango Edition

11TH LATIN AMERICAN CONFERENCE ON PATTERN LANGUAGES OF PROGRAMS

Buenos Aires, Argentina

This talk is based on the following paper:

Terceiro, Antonio. 2016. **Patterns for Writing As-Installed Tests for Debian Packages.** Proceedings of the 11th Latin American Conference on Pattern Languages of Programming (SugarLoaf PLoP), November 2016.

PDF: **https://deb.li/pattestdeb**

Documenting patterns

- Common elements:
  - Title
  - Context
  - Problem
  - Forces
  - Solution
  - Consequences
  - Examples
- Several different styles/templates

A note about Patterns conferences

- A breath of fresh air for those used to traditional academic conferences
- Discussion instead of presentation
- Dedicated reading time
  → people **actually read** your stuff

A brief introduction to DEP8

DEP8

Goal: test a package in a context as close as possible from a system where the given package is properly installed

```
$ cat debian/tests/control
Tests: test1, test2

Tests: test3
Depends: @, shunit2

Test-Command: wget http://localhost/package/
Depends: @, wget

$ grep Testsuite: debian/control
Testsuite: autopkgtest
# added for you by dpkg-source from stretch+
# if debian/tests/control exists
```

Tooling: autopkgtest

```
$ autopkgtest foo_1.2.3-1.dsc -- null
$ autopkgtest foo_1.2.3-1_amd64.changes -- null
$ autopkgtest -B . -- null

$ autopkgtest … -- lxc --sudo autopkgtest-sid-amd64
$ autopkgtest … -- qemu /path/to/img
```

Pattern #1
Reuse Existing Tests

Upstream provides tests. They are intended to run against the source tree, but still they are useful to verify whether the package works (*context*)

However, **there are no "as-installed" tests** (*problem*)

- maintainer might lack time or skills to write tests …
- but upstream already wrote some tests

(*forces*)

Therefore:

Implement as-installed tests as a simple wrapper program that calls the existing tests provided by upstream

(*solution*)

Reusing **unit tests** is very useful for library packages

Reusing **acceptance tests** is useful for applications

```sh
#!/bin/sh
# ...
set -eu
# ...
for testbin in /usr/bin/lxc-test-*; do
    STRING="lxc-tests: $testbin"
    [ ! -x "$testbin" ] && continue
    # ...
    OUT=$(mktemp)
    $testbin >$OUT 2>&1 && pass "$STRING" \
        || fail "$STRING" "$testbin" "$OUT"
    rm $OUT
done

[ "$TEST_FAIL" != "0" ] && exit 1

exit 0
```

Pattern #2
Test the Installed Package

The goals of DEP-8/autopkgtest is to test the package as installed.

Tests that exercise the source tree do not effectively reproduce users' systems

- Some test suites will rely on absolute file paths (bad)
  - `__FILE__` in Ruby
  - `__file__` in Python
- Some test suites will rely on the testing framework in use to setup the environment

Therefore:

Remove usage of programs and library code from the source tree in favor of their installed counterparts.

- Programs can be called directly by name (they are in $PATH)
- Libraries can be imported/linked against without any extra effort (they are in the standard places)
- No build is nececessary (maybe only the test themselves)

```
if [ -z "$ADTTMP" ]; then
  # if *not* running under autopkgtest,
  # use programs and libraries from the
  # source tree,
  export PATH="$SOURCE_ROOT/bin:$PATH"
  export LD_LIBRARY_PATH="$SOURCE_ROOT/lib"
fi
```

```ruby
# THIS IS AN ABERRATION
require File.expand_path(__FILE__, '../../lib/library')

# Assuming the testing framework sets up the
# environment correctly, the above can be
# replaced with something like the following:

require 'library'
```

Pattern #3
Clean and disposable test bed

We want reproducible tests, so everything the test needs to work must be explicit

Tests must reproduce the environment a user gets when installing the package on a clean system

- Reproducibility comes from automation
- Automation has an upfront cost
  (usally worth it in the long run)

Therefore:

Use virtualization or container technology to provide fresh test systems

- Package dependencies must be correct
- Packages needed for the test but not for normal usage must be specified in the control file
- Further automation can be scripted in test scripts (e.g. web server setup)
- While writing the tests themselves it is useful to run them against a "dirty" system; but you should test on a clean one before uploading

Examples

- autopkgtest supports different virtualization options, including none (*null*)
- Debian CI uses LXC. QEMU will be used in the future
- Ubuntu autopkgtest uses QEMU and LXC

Pattern #4
Acknowledge Known Failures

A package has an extensive test suite

The majority of tests pass successfully, but some fail

- a test may fail for several reasons
- of course, ideally we want 100% of the tests passing
- Failures needs to be investigated
- how severe is each failure?
  - are all features and corner cases equally important?
- how much effort is required to fix broken tests?

Therefore:

Make known failures non-fatal

- Passing tests act as regression test suite
- list of non-fatal failures can be used as a TODO list
- one should probably not postpone fixing the underlying issues forever

```
KNOW_FAILURES=$(dirname $(readlink -f $0))/known-failures.txt
# ...
for t in $tests; do
  if ruby2.3 test/runner.rb $t >log 2>&1; then
    echo "PASS $t"
    pass=$(($pass + 1))
  else
    if grep "^$t$" $KNOW_FAILURES; then
      fail_expected=$(($fail_expected + 1))
      echo "FAIL (EXPECTED) $t"
      # ...
    else
      fail=$(($fail + 1))
      echo "FAIL $t"
      # ...
    fi
    # ...
  fi
  total=$(($total + 1))
done
# ...
if [ $fail -gt 0 ]; then
  exit 1
fi
```

Pattern #5
Automatically Generate Test Metadata

- Teams have large amounts of similar packages which could be tested with similar code
- Upstream communities usually have conventions on how to run tests

Similar packages tend to have similar or identical test control files

- duplicated test definitions are bad
- Some packages will need slight variations

Therefore:

Replace duplicated test definitions with ones generated automatically at runtime.

- automatically generated definitions can be updated centrally
- handling test environments is also managed centrally
  - e.g. making sure the tests are running against the installed package

we do this with **autodep8(1)**

```
# package: ruby-foo
$ grep ^Testsuite debian/control
Testsuite: autopkgtest-pkg-ruby

$ autodep8
Test-Command: gem2deb-test-runner \
  --autopkgtest \
  --check-dependencies 2>&1
Depends: @, «build-dependencies», \
  gem2deb-test-runner
```

Also supported:
Perl, Python, NodeJS, DKMS, R, ELPA, Go

Pattern #6
Smoke Tests

- Not all packages provide tests
- Sometimes features are provided
  by the packaging and not by upstream
  (e.g. maintainer scripts, service
  definitions)

The package maintainer wants to add tests to make sure that high-level functionality works.

- Testing internals may be hard (and should be done upstream)
- Packaging-specific tests might be justifiable

Therefore:

Write smoke tests that exercise functionality of the package and check for expected results.

A *smoke test* covers the main and/or most basic functionality of a system.

smoke → fire

Even the simplest test case
(e.g. `myprogram --version`)
could catch:

- Silent ABI changes
- Issues in dependencies
- Invalid instructions
- Packaging issues
  (myprogram: command not found)

```
chef-solo -c debian/tests/config.rb -j debian/tests/node.json

test_install_package() {
  assertTrue 'dpkg-query --show vim'
}

. shunit2
```

Pattern #7
Record Interactive Session

- Some packages predate the pervasiveness of automated testing
- Sometimes writing automated tests upfront is not so easy
  (e.g. experimental interfaces)

You want to provide tests for a package that provides none.

some programs will have a clear boundary with its environment, e.g.

- CLIs
- GUIs
- listening server sockets

Therefore:

Record sample interactions with the program in a way that they can be "played back" later as automated tests.

- install the package on a clean testbed
- Exercise the interface, and verify results match expected/documented behavior
- record that interaction in an executable format (YMMV)

```
$ cat examples/cut.txt
$ echo "one:two:three:four:five:six" | cut -d : -f 1
one
$ echo "one:two:three:four:five:six" | cut -d : -f 4
four
$ echo "one:two:three:four:five:six" | cut -d : -f 1,4
one:four
$ echo "one:two:three:four:five:six" | cut -d : -f 4,1
one:four
$ echo "one:two:three:four:five:six" | cut -d : -f 1-4
one:two:three:four
$ echo "one:two:three:four:five:six" | cut -d : -f 4-
four:five:six
```

```
$ clitest examples/cut.txt
#1      echo "one:two:three:four:five:six" | cut -d : -f 1
#2      echo "one:two:three:four:five:six" | cut -d : -f 4
#3      echo "one:two:three:four:five:six" | cut -d : -f 1,4
#4      echo "one:two:three:four:five:six" | cut -d : -f 4,1
#5      echo "one:two:three:four:five:six" | cut -d : -f 1-4
#6      echo "one:two:three:four:five:six" | cut -d : -f 4-
OK: 6 of 6 tests passed
```

Final remarks

- These patterns document solutions for autopkgtest-related design issues
- hopefully they are useful for you
- Some patterns solve the same problem
- Can you identify other patterns?

plug: ci/autopkgtest BoF
Friday 15:30 — "Bo" room

Learn more

Paper PDF
https://deb.li/pattestdeb

Debian CI documentation
https://ci.debian.net/doc/

Tutorial: Functional testing of Debian packages
(DC15 talk; transcription at Debian CI docs)